Cleaning Up Wastewater

The Coast Guard, state and federal regulators, and the cruise ship industry collaborate to improve wastewater quality.

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We all know that the quality of drinking water is stringently regulated. But did you know that wastewater is also regulated? In fact, some of the wastewater discharged by cruise ships traveling in Alaska's waters is actually clean enough to drink! Perhaps drinkable wastewater does not sound too exciting, but the partnership and technology that has created it definitely is.

Regulating Wastewater…as a Team

Alaska is renowned for its spectacular scenery, and cruise ships are a highly visible part of that scene. Each year, the ships transport more than one million people around the beautiful coastlines, bringing with them great revenue—and leaving behind a considerable amount of wastewater. Concerned by this growing environmental pollution, Alaska has spent the last decade focused on implementing cleaner wastewater standards. The result has been crystal clear success.

In 1999 the Alaska Department of Environmental Conservation (ADEC) organized the Alaska Cruise Ship Initiative (ACSI) to review the cruise ship industry's waste management and disposal practices within Alaskan waters. There were many groups involved, including the U.S. Coast Guard, Environmental Protection Agency (EPA), cruise industry representatives, various Alaskan tribes, environmental groups, and concerned Alaskans. It quickly became apparent that the concern first voiced by Alaskans was shared by many.

In a great display of solidarity, the regulatory agencies

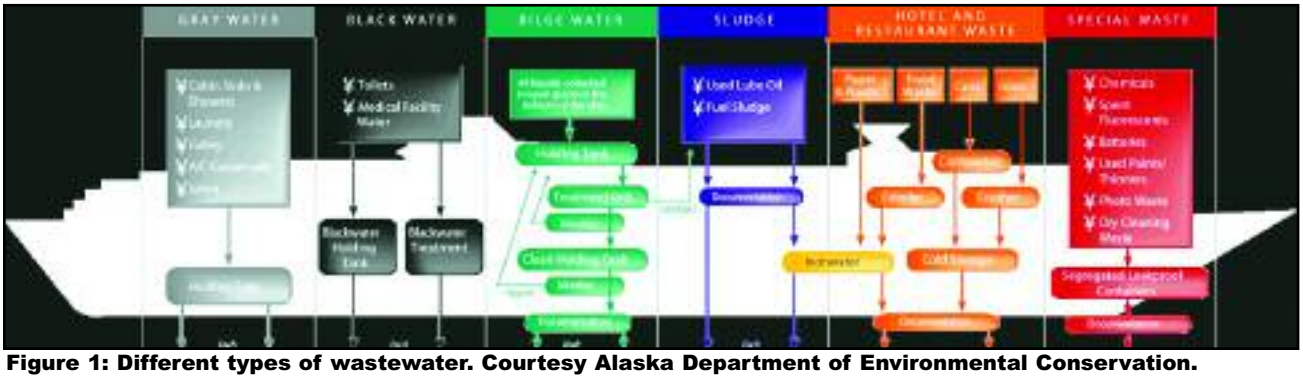

Figure 1: Different types of wastewater. Courtesy Alaska Department of Environmental Conservation.

and the cruise ship industry approached the problem from the same side. All parties seemed willing to contribute as much assistance and information as possible. Mr. David Eley, a consultant at that time for ADEC, noted that "cruise ships are very competitive in marketing, but, when it comes to such matters as environmental standards and security, they all work very closely together. They know that one accident or dirty discharge affects the health of the entire industry, not just one line. One definitely gets the impression that the cruise industry feels that collaboration is not only the right thing to do, it is good business practice."

While federal standards already defined concentration limits of certain pollutants, many unknowns remained. How much wastewater the cruise ships were actually discharging was not really known. The ACSI set out to establish baseline information regarding the wastewater discharges, enlisting most of the cruise ships to conduct voluntary wastewater sampling during the summer of 2000. The sampling included treated blackwater (such as sewage) and graywater (such as wastewater from showers, the galley, and laundry).

There were no standards for graywater at that time. However, the Coast Guard required that blackwater waste from cruise ships contain no more than 200 fecal coliforms per 100 ml. Fecal coliform is a bacteria found in the intestines of mammals and is used as an indicator that other disease-causing organisms may be present. ACSI's sampling revealed that the blackwater contained as many as 16 million fecal coliform per 100 ml and that the graywater contained as many as 32 million fecal coliform per 100 ml. Needless to say, the surprising results demanded immediate improvement.

The Alaska legislative community sprang into action, and the first set of regulatory improvements was passed by Congress in December 2000, with Title XIV-Certain Alaska Cruise Ship Operations. These regulations set wastewater discharge standards for large cruise ships in Alaskan waters. Tasked with implementing and enforcing Title XIV, the Coast Guard soon after published Title 33 of the U.S. Code of Federal Regulations, Part 159, Subpart E, which prescribed the regulations governing the discharges. Alaska Statute 46.03.460 – 46.03.490 joined the federal law in July 2001, placing its own set of strict guidelines on wastewater discharge. This statute also established ADEC's Commercial Passenger Vessel Environmental Compliance (CPVEC) program to ensure cruise ship compliance with the established discharge standards. Regulation 18 AAC 69, which became effective in November 2002, presented the requirements necessary to join the CPVEC program.

Throughout the two years that these various regulations were being formed, the cruise ship industry continued to play a valuable role in their development. Recognizing that lots of money and time would need to be invested to improve the wastewater discharges, the industry was understandably eager to have the standards established. Set standards allowed the industry to contract for new, advanced wastewater treatment technologies.

The Regulations Take Effect

A major concern since the beginning of the Alaska Cruise Ship Initiative was not just the lack of informa-

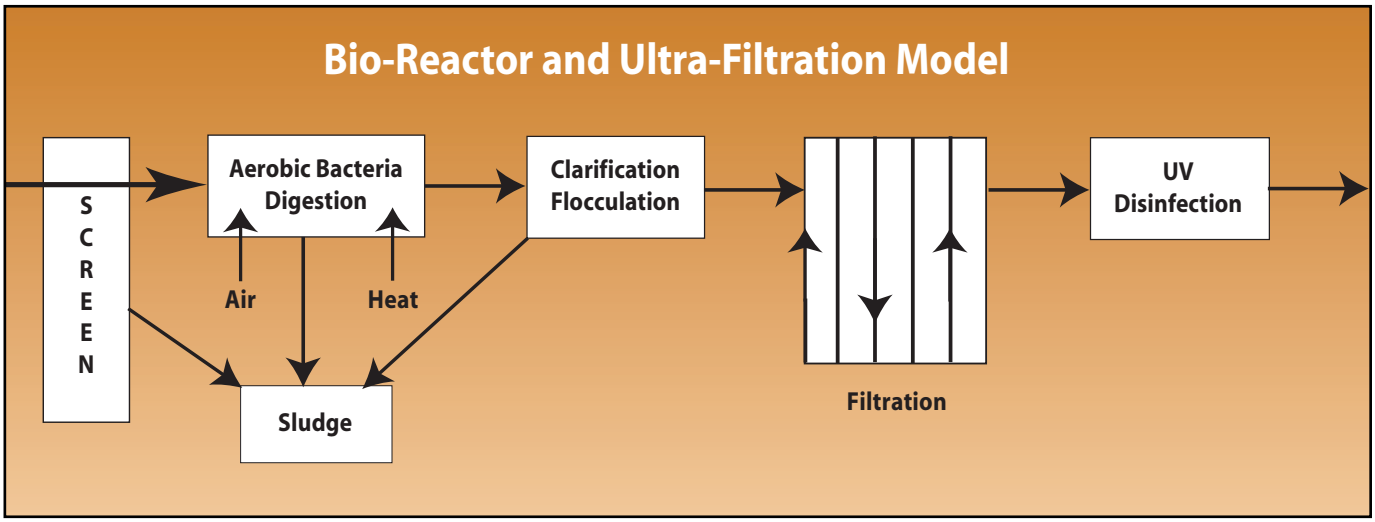

Figure 2: Wastewater treatment systems. Courtesy Mr. David Eley and Ms. Carolyn Morehouse, Cape Decision International Services, Inc.

tion regarding the type of wastewater being discharged (Figure 1), but also the location and quantity of the discharges. With the passing of the various regulations, this information is now effectively captured and monitored. Specifically, the state's CPVEC program requires that each ship maintain comprehensive records of its wastewater discharges. Included in these records are the amount and types of pollutants being discharged.

Figure 3: Scanship advanced wastewater treatment system on a Norwegian Cruise Line vessel. Pictured are two shipboard marine engineers charged with running the system. Courtesy Norwegian Cruise Lines.

Understandably, there is some overlap between the federal and state requirements, so ADEC (specifically, its CPVEC program staff) and the Coast Guard work together closely. For example, if a ship plans to discharge in Alaskan waters, it must provide both ADEC and the Coast Guard with a vessel specific sampling plan (VSSP). The VSSP contains the intended sampling techniques and analytical testing methods of the ship's discharge; it must demonstrate that samples will be representative of the wastewater discharged from that specific ship.

According to Ms. Moana Leirer, an environmental program specialist with ADEC, large cruise ships—which are defined by Alaskan law as 250+ passengers and federal law as 500+ passengers—have one of three options for wastewater discharge that must first be approved by the CPVEC program. These ships can:

1. hold their wastewater, discharging it outside of Alaskan waters (wastewater is therefore not sampled);
2. discharge their wastewater once they are at least one nautical mile from shore and traveling at least six knots (wastewater samples are required and must meet certain effluent standards); or
3. operate advanced wastewater treatment systems that are certified by the Coast Guard for continuous discharge.

A continuous discharge of wastewater, allowed by option three, initially sounds contradictory to the environmental concerns that provided the impetus for the many wastewater discharge regulations. However, the advanced wastewater treatment systems employed with this option are discharging some of the cleanest wastewater ever seen.

Advanced Wastewater Treatment Systems

In addition to the great partnership forged between the regulatory agencies and industry for this massive environmental cleanup, the second part of this success story is the technology that has been developed to improve the wastewater itself. While the regulations were first being formed, many of the cruise ship companies were already evaluating several advanced wastewater treatment systems. These included chemical treatment and mechanical decanting, activated oxidation and oxidant disinfection, reverse osmosis filtration, and bio-reactor/filtration.

Today, while some employ a reverse osmosis filtration system, the majority of cruise ships are using various combinations of enhanced bio-reactor/filtration systems. There are currently four basic designs from dif-

ferent manufacturers—Hamworthy, Rochem, Scanship, and Zenon being the most popular—but all function relatively the same (Figure 2). Hamworthy, Scanship (Figure 3) and Zenon are each biological reactor and ultrafiltration systems, while Rochem is a reverse osmosis ultrafiltration system.

The bio-reactor/filtration systems use an integrated system of enhanced aerobic digestion and low-pressure membrane filtration to treat the wastewater. Tank collection and sorting of waste that contains oils is critical to the process, since most of the systems cannot handle the introduction of oils. Soapy materials and biological agents are the primary targets for treatment. Ultraviolet radiation, which prevents reproduction of live bacteria like fecal coliform, is typically applied to the wastewater before it is sent to a holding tank or discharged overboard. Filtration is essential to all systems in sorting out solids, which are then handled by incineration or other solid waste disposal methods. One of the drawbacks of these bio-reactor/filtration systems, which also occurs with the reverse osmosis system, is that solid sludge is produced and must, therefore, be properly handled and disposed.

Maintaining Quality Assurance

As mentioned earlier, any cruise ship operating an advanced wastewater treatment system that wishes to have continuous discharge allowances must be certified by the Coast Guard for this purpose. First, though, each ship must submit the required VSSP to ADEC for approval. Once approved, the VSSP is submitted to the Coast Guard Captain of the Port, along with certification that the ship's treated wastewater already meets the minimum regulatory standards. The ship must present satisfactory sampling results from five separate days over a 30-day period.

Also crucial to receiving the continuous discharge permit is the development of a quality assurance/quality control plan (QA/QCP), which formalizes and standardizes the manner in which discharge sampling tests are collected and analyzed. To best ensure accurate samples, the QA/QCP also requires duplicate sampling, sampling audits, and a lab technical systems audit. It also lists all the pollutants to be tested and the EPA analytical methods to be used.

The QA/QCP must be approved by all affected parties, including the Coast Guard, ADEC, each participating laboratory project manager since multiple labs can be used to test samples, and the overall project quality assurance officer who oversees all the labs. This multiple approval requirement helps standardize the lab work and provides some oversight to ensure that the labs provide consistent data.

Once certified for continuous discharge, the Coast Guard requires the ship to submit two samples per month. The ship is also tested randomly twice per season by a third-party sampling team—once for conventional pollutants and once for conventional and priority pollutants. All testing is paid for by the cruise ships. These samples are closely monitored by the Coast Guard and ADEC, most notably through the QA/QCP.

To remain eligible for the continuous discharge permit, each ship's QA/QCP must be updated yearly to include the following information:

- sampling techniques and equipment;
- sampling preservation methods and holding times;
- transportation protocols, including chain of custody;
- lab analytical information including methods used, calibration, detection limits, and the lab's internal QA/QC procedures;
- quality assurance audits to determine the effectiveness of the QA program; and
- procedures and deliverables for data validation, to assess data precision and accuracy, the representative nature of the samples drawn, comparability, and completeness of measure parameters.[1]

While each ship is allowed to maintain its own QA/QCP, the majority of the 47 large cruise ships transiting Alaskan waters during the 2005 season have been represented by the North West Cruise Ship Association (NWCA) and use its specific QA/QCP (Figure 4).

Sampling

The number of samples in each sampling event is based upon the ship's configuration, its wastewater management practices, and the wastewater quantities discharged during the sample team's visit. Blind sample duplicates are also collected, which assess overall method variability and can assess bias or analytical errors not otherwise detected by the lab.

Mr. David Wetzel, president of Admiralty Environmental and lab project manager for NWCA's QA/QCP sampling project, helped develop the initial

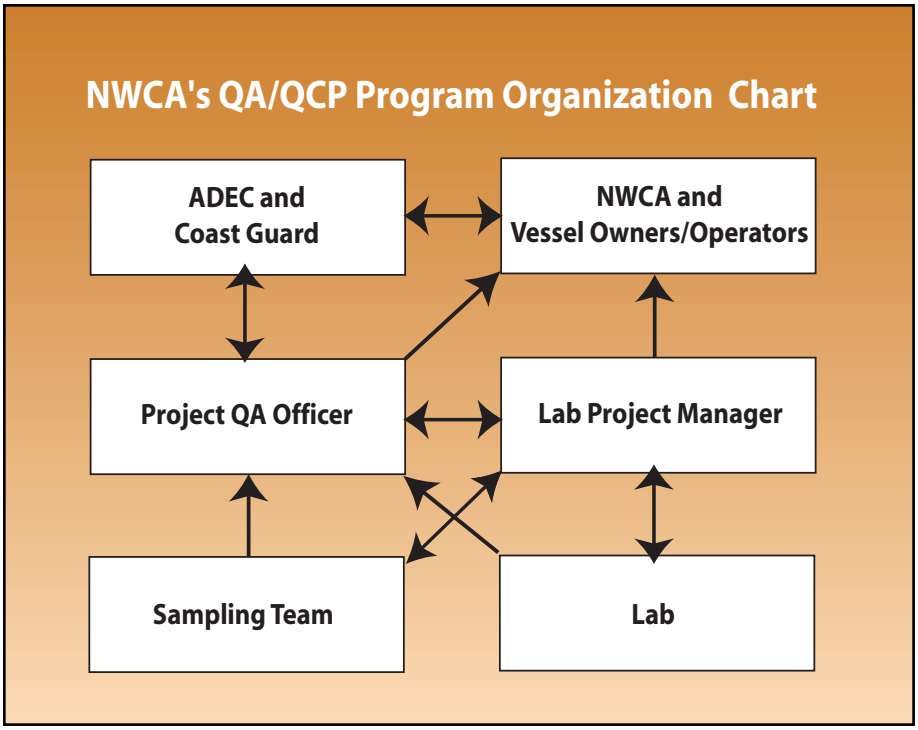

Figure 4: North West Cruise Ship Association's QA/QCP organization chart. Courtesy North West Cruise Ship Association.

set of sampling standards and lab analysis. According to Mr. Wetzel, reliable and representative samples are crucial to achieving valid readings. Therefore, specific sample collection procedures are detailed in each QA/QCP and each ship's VSSP is also submitted to the sampling team. With all groups working from the same documents, there is a stronger certainty that consistent sampling methods are followed and that samples are collected from appropriate and representative locations.

The Coast Guard also verifies installation of the sampling ports on the ships and reviews operations of the advanced wastewater treatment systems during their annual vessel examinations. Additional verification occurs during sampling events because exactness is vital to obtaining a true reading. For example, if a sample port is located too close to certain equipment, then the wastewater has not had a chance to mix before discharging and can produce a tainted sample.

While a third-party sampler takes all the required wastewater samples, it is the responsibility of the ship owner or operator to submit a report on the analytical results of sampling. The sampling analytical report must include the following:

1. date, time, and onboard location where each sample was collected;
2. sampling technique and analytical testing method used for each sample;
3. quality assurance and quality control analysis of the sampling, analytical testing, and analytical data;
4. analytical results;
5. any deviation from the approved plans submitted under 18 AAC 69;
6. type of wastewater sampled; and
7. if necessary, a notification that re-sampling is occurring. [2]

All sample analysis results are submitted by the independent labs directly to the Coast Guard and are reviewed to ensure that each ship is actually meeting all the requirements. The information is later released by ADEC. While samples do occasionally fall out of range, a compliance scheme allows the Coast Guard to average samples to ensure a ship meets compliance on a monthly basis versus an individual sampling event. Since the QA/QCP's inception in 2002, there has been an average of only one bad sample every two months, but these bad samples are usually later shown to have been tainted.

While it may sound confusing, the primary goal of a QA/QCP is to keep wastewater discharge as clean and pollutant-free as possible. In fact, NWCA's QA/QCP tests for 250 different pollutants, substantially more than the 16 pollutant tests required by the Coast Guard.

Other States Implement Alaska's Standards

Alaska's success story has traveled far, including to such distant states as Maine, Washington, and Hawaii. In a great example of knowing when not to reinvent the wheel, the state of Maine essentially adopted the Coast Guard's existing regulations for Alaska (33CFR159, Subpart E) with only two noticeable changes: substituting "Maine" for "Alaska" and "State of Maine Department of Conservation" for "Coast Guard Captain of the Port." Regulations in Washington have also adopted many of Alaska's regulations but require additional record keeping requirements. Officials in Hawaii are currently working on

similar regulations and have a memorandum of understanding signed, but there are some area-specific concerns. Because freshwater has a negative reaction on coral, Hawaii is understandably—but ironically—worried about too much clean water being discharged with the advanced wastewater treatment systems.

For other states or areas wanting to implement advanced wastewater treatment systems and the requirements that come with them, Mr. Wetzel points out that the focus should first be an agreement among all affected parties of the end goal, such as what types of discharges will be allowed or the quantity of the overall discharge. Mr. Wetzel observed that both the regulatory agencies and industry in Alaska recognized early on that completely eliminating discharges in Alaskan waters was not realistic, but that creating certain discharge standards was a more appropriate goal. Because this mutual agreement and goal recognition were realized early on, Mr. Wetzel notes, the positive changes were implemented so quickly.

EPA is also looking closely at Alaska's success. Authorized to create additional standards at its discretion, EPA is currently in the process of evaluating the cruise ship wastewater discharge requirements in Alaska. It recently distributed a review, "Survey Questionnaire to Determine the Effectiveness, Costs, and Impacts of Sewage and Graywater Treatment Devices for Large Cruise Ships Operating in Alaska," to all cruise ships authorized to carry 500 or more passengers for hire that traveled to Alaska in 2004. EPA also sampled wastewater from cruise ships to evaluate the onboard performance of various advanced wastewater treatment systems. Under Title XIV, EPA plans to develop standards for discharges of blackwater and graywater from cruise ships into Alaskan waters. Proposed changes to existing regulations are expected in mid-2006.

Proving the Technology Valuable

According to Mr. Wetzel, the greatest benefit of advanced wastewater treatment systems is the vast improvement of Alaska's water quality. He notes that these systems have reduced the discharge to being superior to even a municipal discharge on land. Mr. Wetzel attributes these improvements, in large part, to the collaboration between regulatory agencies and industry.

Mr. Eley wholeheartedly agrees. As one of the first participants in the ACSI, Mr. Eley remains involved today as a member of the QA/QCP review team. He remarks that the process from its very beginnings evolved quickly but that everyone was working toward the same goal: "I've never seen new technology and new engineering move so fast. And now all the groups are taking the technology and different practices and moving it forward; doing what's best for the environment."

These systems are not without obstacles, however, notes Mr. Richard Pruitt, director of environmental and public health programs for Royal Caribbean International (RCI). Since RCI installed its first advanced wastewater treatment system in 2001, RCI has endured many learning curves. First, installation of the systems themselves has proven tricky. According to Mr. Pruitt, each system takes up a tremendous amount of space—a precious commodity on ships. Lots of technical resourcefulness is required in figuring out how to fit a system into an already compact area. This task is made especially more difficult since ships—even those in the same class—are often designed differently, thereby presenting each installation with its own set of placement dilemmas.

Financially, there is a huge initial cost in capital, and the continual costs of personnel time and operations, including electricity consumption, are substantial. Mr. Pruitt also observes that the systems themselves are still relatively new and continually being modified to meet the demands of each ship, so there are added costs involved with working out those specific issues. However, despite any drawbacks or concerns, both RCI and Norwegian Cruise Lines have already agreed to install these systems fleet-wide.

In 2003 the cruise ships operating advanced wastewater treatment systems were sampled for 16 conventional pollutants and 160 priority pollutants. The vast majority of these pollutants were not detected, showing a dramatic improvement in the quality of the wastewater. Success is undeniable.

References

[1]Http://www.dec.state.ak.us/water/cruise_ships/pdfs/2004qaqcplan.pdf.

[2] Alaska law 18 AAC 69.055: Sampling and analytical testing report.

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